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March 8, 1866.

Lieut.-General SABINE, President, in the Chair.

Mr. Archibald Geikie was admitted into the Society.

The following communications were read:—

I. “Note on a Correspondence between Her Majesty’s Government and the President and Council of the Royal Society regarding Meteorological Observations to be made by Sea and Land.” By Lieutenant-General SABINE, P.R.S. Received March 8, 1866.

Her Majesty’s Government having been pleased to consult the Royal Society on several occasions in the last few years regarding the proper steps to be taken by this country, under the sanction and authority of its Government, for the prosecution, in cooperation with the Governments of other States in Europe and America, of systematically conducted meteorological observations by Land and Sea, it may be desirable to offer to the Fellows a *résumé* of the correspondence, and of the suggestions which from time to time have been tendered on the part of the Society to the several departments of the State.

The correspondence commenced by a communication from the Foreign Office in March 1852, transmitting, by direction of the Earl of Malmesbury, several documents received from foreign governments in reply to a proposition which had been made to them by Her Majesty’s Government, for their cooperation in establishing a uniform system of recording meteorological observations; and requesting the opinion of the President and Council of the Royal Society in reference to these documents, and more especially in reference to a communication from the Government of the United States of America respecting the manner in which the proposed cooperation might be carried out.

The reply of the President and Council was dated May 10, 1852. It recognized fully the importance of well-directed and systematically conducted meteorological observations, not only for their scientific value, but also on account of the important bearing which correct climatological knowledge has on the welfare and material interests of the people of every country. With reference to a specific proposal for the adoption, by all countries, of a uniform plan in respect to instruments and modes of observation in meteorological researches on land, the President and Council expressed a doubt whether any practical advantage was likely to be gained by pressing such a recommendation in the then state of meteorological science. Many of the principal Governments of the European Continent had already

organized systematic climatological researches throughout their respective States under the superintendence of men eminently qualified by theoretical and practical knowledge, and whose previous publications had obtained for them a general European reputation. The instruments employed in each country had been constructed under the care of the Superintendents, and the instructions for their use drawn up and published by them; the observations were also received by them and reduced and coordinated, and were in this state published periodically by the respective governments. To call on countries so advanced in systematically conducted meteorological observations to remodel their instructions and instruments with the view of establishing uniformity in these respects, was scarcely likely to be successful, especially if the request proceeded from a country which had no similarly organized system extending over its own area. Moreover the discussions which had taken place at the Magnetic and Meteorological Congress assembled at the Cambridge Meeting of the British Association in 1845, which was attended by the Superintendents of the different continental systems, had manifested so marked a disposition on the part of the meteorologists of the different countries to adhere to their respective arrangements in regard to instruments, times of observation, and modes of publication, as to produce a strong conviction that the suitable time for pressing a proposal for the substitution of a uniform scheme, however advantageous in some respects, had not then arrived.

But in respect to *Marine Meteorology* the case was widely different; and the suggestions which the President and Council felt it their duty to offer on that subject had a much more positive character, and were directed to immediate action. An application had been made by the Government of the United States to that of our own country to give a greater extension and a more systematic direction to meteorological observations *made at sea*. Apart from the important scientific bearing of such researches, the well-known publications of Lieutenant Maury had given to the Government of the United States a fair claim to make such an application to that of our own country, to whose commercial interests a practical knowledge of the meteorological statistics of the ocean was not less important than to those of the United States. Accordingly, in their reply to the Foreign Office, the President and Council did not fail to express emphatically their hope that the application for cooperation, thus earnestly addressed by the Government of the United States, might not be addressed in vain.

The following extracts from a memoir addressed by Lieutenant Maury to the Secretary of the United States Navy, printed in "Papers presented to the House of Lords by command of Her Majesty, pursuant to an address dated February 21, 1853," will show that the suggestions thus made by the President and Council, both in regard to Land and to Sea Meteorological Observations, were fully concurred in by Lieutenant Maury, on his return from an official mission to visit and report upon the meteorological estab-

blishments of the principal States of Europe. Lieutenant Maury's memoir is dated November 6, 1852.

“I would recommend that the United States should abandon, for the present at least, that part of the ‘Universal System’ which relates to the Land, and that we should direct our efforts mainly to the Sea, where there is such a rich harvest to be gathered for navigation and commerce. . . . I am induced to make this recommendation in consequence of the evident reluctance with which Russia, Austria, Bavaria, Belgium, and other powers seem to regard any change in their systems of meteorological observations on shore. . . . Each country seems to have adopted a system of its own, according to which its labourers have been accustomed to work, and to which its meteorologists are more or less partial. Any proposition having in view for these systems a change so radical as to bring them to uniformity, and reduce them to one for all the world, would, I have reason to believe, be regarded with more or less jealousy by many. . . . Not so, however, with regard to the Sea; that proposal meets with decided favour and warmest support.”

Lieutenant Maury then quotes largely from the Report of the President and Council of the Royal Society (already referred to), and from the anniversary address of the President of the British Association at the Belfast Meeting in 1852, in illustration of the advantages which navigation and commerce may derive from the extension of maritime researches by the proposed cooperation of Great Britain and the United States.

In June 1854 the Board of Trade informed the President and Council by letter that they were about to submit to Parliament an estimate for an office for the discussion of observations on Meteorology to be made at Sea in all parts of the globe, in conformity with the recommendation of a conference held at Brussels in the preceding year; and that it was their intention to publish from time to time, and to circulate, such statistical results, obtained by means of the observations referred to, as might be considered most desirable by men versed in the science of meteorology, in addition to such other information as might be required for the purposes of navigation. To this end, the Board of Trade were desirous of obtaining the opinion of the Royal Society as to what were the great desiderata in that science, and as to the forms which may be best calculated to exhibit the great atmospheric laws which it may be most desirable to develop.

The Board further stated that, “as it may possibly happen that observations on land upon an extended scale may hereafter be made and discussed in the same office, it is desirable that the reply of the Royal Society should keep in view and provide for such a contingency.”

In their reply to this communication, dated February 22, 1855, the President and Council kept carefully in view the relative importance which the Board of Trade attached to the suggestions which might be offered

respecting *observations to be made at sea*, and *observations to be made on land*; the *immediate* bearing of the one, and the *contingent* and *eventual* bearing of the other. Their reply consequently bore chiefly on points to be investigated by marine observations,—under the several heads of barometric variations; of those of the dry air and of aqueous vapour; of the mean temperature of the air; of the temperature of the sea, and investigations regarding currents; of storms and gales; thunderstorms; auroras and falling stars; and charts of the magnetic variation. (Proc. Roy. Soc., vol. vii. pp. 342–361.)

These were treated of in their generality, as subjects of investigation to be made (in the words of the Board of Trade) “at sea in all parts of the globe.” Nor was the contingency of observations to be made on land upon an extended scale, “which may hereafter be made and discussed in the same office,” overlooked; and to enable the Royal Society to be more fully prepared, and to be ready “to provide for the contingency” whenever it should present itself, the President and Council put themselves in communication with several of their foreign members who were known as distinguished cultivators of meteorological science,—having always in view the possibility that, when the occasion should occur, they might be prepared to offer such suggestions as might facilitate the purpose which had been deemed so desirable by Her Majesty’s Government in the preceding year. The chief difficulty which had then presented itself had been the desire shown by the meteorologists of the different European States to adhere to the instruments, and more particularly to the hours of observation, to which they had been accustomed. The hours had been selected partly on grounds of convenience, and partly in the belief that they were those best suited to receive the corrections required in different localities for diurnal and casual variations. The most hopeful way of surmounting the difficulties in question would obviously be the introduction of instruments which should be *continuously self-recording*; such instruments would in addition supply the exact instants of the maxima and minima of the different phenomena—points greatly required in the discussion of the laws of extensive atmospherical disturbances. At the epoch of the Cambridge Congress in 1845 it was understood that no perfectly reliable instruments for continuous record were in use amongst the continental observers. The self-recording instruments of M. Kreil, employed at the observatories of Prague, Senftenberg, Vienna, and Munich, and which had also been in use for many months at the Kew Observatory, were not *continuously* self-recording, and were also, in the opinion of many, not altogether free from objections. The construction of instruments both in magnetism and meteorology which should serve this important purpose and at the same time be free from causes of error in other ways, had been a cherished object of the Committee of the Kew Observatory from the commencement of that institution. The advance which had been accomplished at a very early period may perhaps best be stated in the following extract from the fourth

report of Mr. Ronalda, its Director, published in the volume of the British Association for 1847, *Trans. of Sections*, page 30. "The preliminary experiments on the photographic registration of the atmospheric electrometer, the thermometer, the barometer, and the declination-magnet having been long since completed and published, and their results having warranted the cost and trouble of constructing apparatus of a durable and convenient character, a declination-magnet and a barometer have been mounted at Kew which scrupulously fulfil the requisite conditions without the intervention of those friction-rollers, levers, pivots, or other mechanism which have hitherto rendered self-registering apparatus so objectionable." Mr. Ronalda added that it was his "intention to provide during the ensuing year complete apparatus on like principles for registering as many of the other meteorological and magnetical instruments as funds will permit."

The instruments which would be required for a complete equipment of a meteorological observatory would be those which should automatically and continuously record (1) the variations of the atmospheric pressure; (2) those of the dry and wet thermometers; (3) those of the force and direction of the wind; and (4) those of the atmospheric electricity. Of these, Nos. 1 and 2, as has been already said, had been devised at Kew in or before 1847. Dr. Robinson's hemispherical-cup anemometer, of which a description was published in 1851 in the *Transactions of the Royal Irish Academy*, and which was immediately adopted at Kew, records, in a manner which I believe is universally held to be unexceptionable, the direction and force of the wind at every instant. The electrometer to which Mr. Ronalda referred in his report of 1847, though highly ingenious and yielding very instructive results, was not *continuously self-recording*. An electrometer fulfilling this condition was consequently a desideratum until Professor William Thomson devised, and caused to be constructed under his own superintendence at Kew, in the spring of 1861, the self-recording electrometer which has been subsequently in successful work at that observatory; thus supplying the fourth apparatus required for a complete meteorological record. It may be added that the Kew Barograph photographs its records self-compensated for temperature; its curves consequently are in immediate readiness for the lithographer or engraver.

Such was the state of instrumental preparation at the Kew Observatory when the untimely death of Admiral FitzRoy, who had been placed by the Board of Trade in charge of the meteorological office established in 1855, occasioned a renewal of the communications which had taken place on the formation of the office, between the Board of Trade and the Royal Society. In a letter dated May 26, 1865, the Board of Trade recalled to the recollection of the Royal Society the recommendations regarding marine meteorology contained in the letter of the President and Council of February 22, 1855, stating that those recommendations had been adopted by the Board as the basis of the proceedings of the meteorological department; and that in conformity therewith instruments and logs had been prepared

and furnished to ships proceeding on distant voyages, and had been returned to the office; and that some progress had been made in carrying into effect the original programme of tabulating these in readiness for statistical charts.

It was further stated that "in 1859 or 1860, the French Government having adopted a system of telegraphing and publishing the actual state of the weather from one place to another, in which Admiral FitzRoy's cooperation had been sanctioned, a considerable part of the vote previously applied to obtaining and digesting observations was devoted to these telegrams; and further, that in 1861, Admiral FitzRoy having grafted on this system of telegraphic communication a system of forecasting the weather, and, on occasions of anticipated storms, the giving of special warnings, communicated by telegraph to the different ports and there made known by hoisting certain signals,—the whole or almost the whole of the funds originally voted for the purpose of observations had thus been diverted from their original scientific purpose to an object deemed more immediately practical."

The decease of Admiral FitzRoy afforded, in the judgment of the Board of Trade, a fitting opportunity to review the past proceedings and present state of the meteorological department, and rendered them desirous of again consulting the Royal Society on the constitution and objects of the department, and the mode in which those objects might be most effectually attained.

The points on which the opinion of the Royal Society was specially requested were the following:—

1. Are the points specified in the letter of the Royal Society of the 22nd of February 1855 still deemed as important for the interests of science and navigation as they were then considered?
2. To what extent have any of these objects been answered by what has already been done by the meteorological department?
3. What steps should be taken for making use of the observations already collected?
4. Is it desirable to make any, and what, further observations on any of the subjects mentioned in the Royal Society's letter of the 22nd of February 1855?
5. What is the nature of the basis on which the system of daily forecasts and storm-warnings established by Admiral FitzRoy rests? Are they founded on scientific principles, so that they, or any part of them, may be carried on satisfactorily notwithstanding Admiral FitzRoy's decease?
6. Can the Royal Society suggest any improvement in the form and manner of the process pursued in forecasts and storm-warnings?
7. Have the Royal Society any general suggestions to make as to the mode, place, or establishment in, at, or by which the duties of the meteorological department can best be performed? it being understood that the Admiralty are willing to undertake to place in the hands of the Hydrographer all those observations which can properly be used in framing charts for the

purposes of navigation, but not those which relate to meteorology proper or meteorological observations on land.

Several documents accompanied this communication,—amongst them a statement by Mr. Babington, chief clerk in Admiral FitzRoy's office, regarding the method adopted in the department in regard to forecasts and storm-warnings; and returns, exhibiting a comparison of the probable force of the wind indicated by signals in the years ending March 31, 1864, and March 31, 1865, and its actual state as reported in the three days following the exhibition of the signals.

The reply of the President and Council was dated June 15, 1865. It suggested the continuance, for the present, of the practice of forecasts and storm-warnings as before, and the continued issue of instructions and forms to such masters of vessels proceeding on distant voyages as might be expected to make a profitable use of them; both these duties to be continued under Mr. Babington's superintendence, by whom in effect they had been carried on for some time previous to Admiral FitzRoy's decease. And it was further recommended that both the system under which the forecasts and storm-warnings had been hitherto carried on, and the extent and value of the information regarding ocean-statistics which had been accumulated in the office of the Board of Trade, should be subjected to a careful examination. These recommendations were adopted; and a Committee has been appointed, of three members, one nominated by the Board of Trade, a second by the Admiralty, and a third by the Royal Society, to report on what has been done, and to suggest any modifications which may appear desirable for the future. The report of this Committee is expected to appear very shortly.

With reference to the subject of Land Meteorology, the President and Council had been apprized by the Board of Trade, in February 1855, that "observations on land upon an extended scale might hereafter be made and discussed in the meteorological department of the Board," and had been requested to be "prepared for such a contingency." In the more recent correspondence in 1865, the subject of land observations was again brought forward, and the Royal Society was invited to offer suggestions in reference to it. Thus appealed to, the President and Council would have failed in their duty if they had not replied fully and explicitly to a request proceeding from Her Majesty's Government,—carefully restricting themselves, in their reply, to such suggestions as their own knowledge enabled them to affirm with confidence could be carried into practical operation, and which at the same time enabled them to respond to the more general inquiry in the letter from the Board of the 26th of May 1865, viz. "Have the Royal Society any suggestions to make as to the mode, place, or establishment in, at, or by which the duties of the meteorological department can best be performed?"

The reply of the President and Council was as follows:—"There remain, therefore, to be noticed solely the considerations which relate to 'Meteorology proper,' *i. e.* to the Land Meteorology of the British Islands. We

find that the principal states of the European Continent have almost without exception formed establishments for the collection and publication periodically of the meteorology of their respective countries. The arrangements consist usually of a central office, at which instruments and instructions are provided for a number of stations, greater or less, according to the area which they represent; at which stations observations are made and transmitted to the central office, where the results of all are reduced, co-ordinated, and published. The small extent of the area comprised by the British Islands in comparison with the territories of many of the European States may require *fewer* stations; but in a matter now so generally attended to and provided for, it seems scarcely fitting that our country should be behind others. There is, moreover, a peculiarity in the meteorological position of the British Islands in respect to Europe generally as its north-western outpost, in consequence of which an especial duty appears to devolve upon us. M. Matteucci, in a very recent publication, has already made the important remark that extensive atmospheric disturbances which first invade Ireland and England are those which, in winter more especially, extend to and pass the Alps (although somewhat retarded by them), and spread over Italy; and that storms so telegraphed from England have actually reached Italy, and have been found to correspond with the accounts subsequently received from Italian Mediterranean Ports.

“A few stations—say six, distributed at nearly equal distances in a meridional direction from the south of England to the north of Scotland, furnished with self-recording instruments supplied from and duly verified at one of the stations regarded as a central station, and exhibiting a *continuous* record of the temperature, pressure, electric and hygrometric state of the atmosphere, and of the force and direction of the wind—might perhaps be sufficient to supply authoritative knowledge of those peculiarities in the meteorology of our country which would be viewed as of the most importance to other countries, and would at the same time form authentic points of reference for the use of our own meteorologists. The scientific progress of meteorology from this time forward requires indeed such continuous records—first, for the sake of the knowledge which they alone can effectively supply, and, next, for comparison with the results of independent observation not continuous. The actual photographs or other mechanical representations, transmitted weekly by post to the central station, would constitute a lithographed page for each day in the year, comprehending the phenomena at all the six stations, each separate curve admitting of exact measurement from its own base-line, the precise value of which might in every case be specified.

“The President and Council suggest that the observatory of the British Association at Kew might with much propriety and public advantage be adopted as the central meteorological station.”

It has been already shown, in the earlier part of this communication,

that the Kew Observatory possesses all the instruments required in a complete system of continuous self-recording meteorological observation. These are well known to the Directors of many meteorological observatories both at home and abroad, who in several instances, after personal examination, have applied for and obtained for their own establishments similar instruments prepared under the Superintendent of the Kew Observatory, Mr. Balfour Stewart. Thus, Barographs on the Kew pattern have been supplied to Oxford, St. Petersburgh, and Coimbra; Anemometers to St. Petersburgh, Odessa, Melbourne, Coimbra, Ascension, Madras, Agra, and two meteorological stations established by Admiral FitzRoy; Electrographs to Lisbon and Coimbra. There would be no difficulty (as was stated in the letter to the Board of Trade) in preparing instruments at Kew for affiliated meteorological stations in Britain, and in arranging for their verification and comparison with the Kew standards, as well as in giving to those in whose hands they may be placed such instructions as may ensure uniformity of operation. Such functions constitute in fact part of the original purposes of the Institution at Kew, and are in continual exercise both for magnetism and for meteorology.

It is not unreasonable to anticipate that the success of such a system of continuous self-recording meteorological observation, exemplified over the limited area of the British Islands, might occasion its wider extension, and thus contribute to the virtual fulfilment of the desire expressed by Her Majesty's Government in 1852 "for the adoption of a general and uniform plan of making and recording meteorological observations."

POSTSCRIPT, March 23.—Since this "Note" was communicated to the Royal Society, I have read with great satisfaction the opinion expressed in the following extract from the "Report of a Committee assembled at the Board of Trade to consider certain questions relating to the Meteorological Department of the Board," pages 52, 53:—

"There is no doubt that self-recording instruments are urgently needed in the present state of meteorological science, and that they will soon in all probability be largely employed both in this country and abroad. Their advantages are manifest. By reason of the continuity of their records, no wave or variation of any description in any of the meteorological elements can escape notice, and the course of that wave or variation can be tracked with certainty from station to station, and its modification at the time of reaching each station in succession can be accordingly observed. For the same reason one difficulty, now seriously felt, in charting the weather, viz. that which arises from observers in different places and countries adopting different hours of observation, would wholly disappear; and a further difficulty, viz. that which arises from observers being unpunctual to their professed hours of observation, would disappear also. The unvarying accuracy of the record is an advantage of still greater importance than might be expected by those who have had no experience of the frequent

errors to be found in meteorological registers. Each error creates considerable confusion ; it throws doubt on the observations accurately made at neighbouring places ; and that doubt cannot be removed except by the continuity of the records at those places. This continuity is unattainable unless the weather happens to be uniform over a wide district, or unless observations are made at many more places than would be needed, if reliance could be placed upon the accuracy of the observers. Another advantage of self-recording instruments is that their records are independent of particular scales. Their notation is in lines and curves that can be measured with equal facility according to any desired scale. The thermometer lines could be measured at pleasure according to Fahrenheit's scale, as used in England ; to the Centigrade, as in France ; or to Reaumur's, as in Germany. The barometer lines could be measured with equal ease in English inches, in millimetres, or in Paris feet. For the various reasons we have mentioned, self-recording instruments are of eminent local and international utility. The establishment of a series of them in England would confer a wide benefit. They would give precision and fulness to the charts of our own weather ; they would set an example that foreign governments would soon follow ; and they would afford material in a very acceptable form to meteorologists at home and abroad for the discussion of the weather of Europe at large."

II. "On the Action of Compasses in Iron Ships." By Mr. JOHN LILLEY. Communicated by Sir W. SNOW HARRIS, F.R.S. Received February 9, 1866.

Although many ably-written papers upon this subject have at various times appeared, none of them seem to be of that simple practical character as to supersede the necessity of any further investigation of the subject, or deter the author from submitting to the Royal Society the results of many years' practical experience in the construction of the mariner's compass, and its adjustment in iron ships. These results are given with a view to advance our knowledge of this important and great practical scientific question, and to add still more to the security of life and property. In the present day, when iron shipbuilding is so widely extending, it is presumed that the most humble offering tending to place the directive action of the compass beyond the reach of disturbing magnetic forces may not be unacceptable.

It is unnecessary here to enter into a mathematical investigation of the properties or magnetic condition of iron ships, this part of the subject having been already fully treated and developed by many learned men. The author rather proposes to confine himself to the consideration of the probable causes of the disasters so frequently attendant on the navigation of iron and other ships, through defective compass guidance ; such disasters, according to the author's experience, may be traced, in a large majority of cases, to one or other of the following causes :—